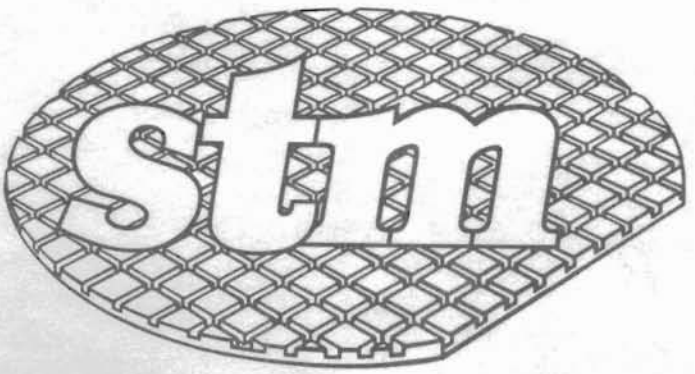


STM Electronics Corporation

PIED PIPER™

Authorized Dealer Manual

PIED PIPER™

DEALER MANUAL

Section	Subject
II	PIED PIPER
III	Peripherals
IV	Expansion
V	Warranty/Service
VI	Pricing
VII	Hardware Information
VIII	Software Information
IX	User's Manual
X	Advertising/Promotion
XI	Dealer Information
	INDEX

IN THIS SECTION:

- Overview of the PIED PIPER
- Features and Benefits
- Comparison Chart
- PIED PIPER Accessories
- Media Specifications

The PIED PIPER portable microcomputer with integral 1Mb drive

PIED PIPER™

The PIED PIPER introduces a new breed of low cost, high performance computers for both beginners and advanced users who demand that their system expand with their requirements. The PIED PIPER is the least expensive, truly portable, fully featured, expandable computer with integral disk drive. It is compatible with both video monitors and televisions.

Designed so both the beginner and sophisticated user will find it a pleasure to operate, the PIED PIPER offers an excellent combination of hardware and software at a surprisingly low price.

THE FULLY FEATURED PIED PIPER INCLUDES:

- PIED PIPER with built-in floppy disk.
- CP/M 2.2 operating system and utilities.
- PIED PIPER utilities.
- The Perfect Software package of word processing, spelling checker, spreadsheet, and filer programs.
- Instruction manuals for the system and application programs.

PIED PIPER™

HARDWARE	FEATURES	BENEFITS
Processor	Z80A microprocessor/4Mhz	The Z80A provides access to an enormous library of existing programs and the 4Mhz (speed) allows the programs to run in approximately half the time of conventional micro computers.
Memory	64K bytes of RAM 4K bytes of read only memory 2K bytes of video display buffer. 2K bytes of read only memory for character generation.	The PIED PIPER uses a full 64K of RAM, plus, by using other memories, it allows as much user space as possible.
Keyboard	Full size, ASCII typewriter-style keyboard; 61 keys.	With this typewriter style keyboard, there is no need to relearn key locations.
Printer	Centronics type parallel printer port.	Accepts any of the letter quality and/or dot matrix printers which use a standard parallel port connector.
Display Capability	24 lines of 80 characters for video monitor. 24 lines of 40 characters for TV with horizontal scrolling feature to view 80 columns. Upper/lower case plus character graphics.	View standard 24 x 80 format on your video monitor or use a TV set.
RF Modulator	Connector for an RF modulator allows display on TV.	The connector on the back of the PIED PIPER allows the use of any TV using the ASTEC UM 1381 TV modulator.

PIED PIPER™

HARDWARE	FEATURES	BENEFITS
Floppy Disk Drive	5-1/4" slimline drive with 1M byte of unformatted storage, 784K bytes formatted.	The most significant part of the PIED PIPER is its high capacity disk drive. The PIED PIPER has twice the capacity of most other portables and it reads/writes much faster to the disk than many of these other computers.
Expandable	See Section IV for latest details	The user can personalize the PIED PIPER to solve his/her problems.

SOFTWARE	FEATURES	BENEFITS
Operating System	CP/M 2.2 and PIED PIPER utilities, including formatting, file transfer and backup with one disk drive.	The PIED PIPER comes complete with the industry standard operating system CP/M. Additionally the PIED PIPER includes many utilities in order to make it user friendly.
Application Programs	Perfect Writer - Word processing. Perfect Speller - 50,000 word spelling dictionary. Perfect Calc - Electronic spread sheet Perfect Filer - Filing system with form letter/ mail merge capability.	Expensive software options on many 'name brand' computers are standard on the PIED PIPER. We invite you to use these powerful, yet easy to understand integrated application software packages to solve 80% of your business needs.
Options	See Section VIII (Software) for a complete list of software.	The PIED PIPER's powerful hardware and high capacity disk storage system lends itself perfectly to many popular CP/M programs.

PIED PIPER™

GENERAL DESCRIPTION

	Features	Benefits
Dimensions	Height: 4.0 in (10 cm) Width: 20.2 in (51 cm) Weight: 11.5 lbs (5.6 kg)	Through its unique design, the PIED PIPER is truly lightweight and easy to carry.
Electrical Requirements	115 VAC 60 Hz/220 VAC 50 Hz (Optional)	Power options allows use of the PIED PIPER anywhere.
Environmental	Temperature 50°F-95°F (10°/C-35°/C Humidity 20%-80%	If you can take it, the PIED PIPER can! 3 PIED PIPERS ran non-stop 8 hours/day in the outrageous temperatues at NCC in Anaheim, May, 1983. When the temperatures reached 113°, the exhibitors rebelled, but the PIED PIPERS kept on working.

PIED PIPER™

	Z80	CP/M	RAM 64K	Disk Storage	Parallel Printer Port	Perfect Software Package	Weight	Nationwide Service	Price
PIED PIPER	Standard	Standard	Standard	784K	Standard	Standard	11.5 lbs	yes	$1,299
Compaq	N/A	$60	Standard	320K	Standard	$1,230	31 lbs.	no	$4,285
Kaypro II	Standard	Standard	Standard	380K	Standard	Standard	26 lbs.	no	$1,595
Commodore 64	$179	$300	Standard	170K	Standard	$1,230	15 lbs.	no	$2,699
Epson HX20	N/A	N/A	N/A	N/A	N/A	N/A	4 lbs.	No	$795

Compare the PIED PIPER. It's not the cheapest, it is the BEST VALUE in microcomputers today.

Compare the PIED PIPER against any competitor yourself:

	PIED PIPER	Competitor
Price	$1,299	_____
64K RAM	Yes	_____
Disk storage	784K	_____
Business software	Yes	_____
CP/M	Yes	_____
Printer Port	Yes	_____

Note: Competitive information extracted from manufacturer's literature for comparison purposes only. Specifications subject to change without notice.

ACCESSORIES

Monitor Stand	An attractive slim stand will allow you to store your PIED PIPER and monitor in a convenient setting.
Printer Cable	The PIED PIPER printer cable will connect your computer to any standard parallel printer (Centronics type).
User's Manual	Replacement User's Manuals are available.
R.F. Modulator	The R.F. Modulator permits you to use your television as a display screen. It provides a view of 24 lines of 40 characters with horizontal scrolling feature to view 80 columns. It simply plugs into a jack at the back of the PIED PIPER.
PIED PIPER Carry Case	Provides additional protection while you are on the go. It has storage space for diskettes, electrical cord. R.F. Modulator and manuals. All this in one slim, smart and attractive carrying case.
Diskettes	High quality floppy diskettes that provide reliable data storage are available. Double-sided, double density, 96 TPI and a reinforced hub ring are included. For details, see pages 8 and 9 in this section.

PIED PIPER™

The PIED PIPER is:

- POWERFUL
- EXPANDABLE
- PORTABLE
- AFFORDABLE

IN THIS SECTION:

- Floppy Disk
- Video Display
- TV Display
- Printer

Floppy Disk Drive: Add a floppy disk drive to your PIED PIPER and you'll have 1.6 megabytes of usable storage! This external disk drive has the same specifications as the internal floppy disk. Because of the high capacity of this system, leave the extra disk behind when you're on the go and the PIED PIPER is truly portable.!

Let's compare the two disk PIED PIPER to a 'name brand' computer:

	PIED PIPER	NAME BRAND
Two Disks Formatted Storage	1568K	380K
Suggested List (with two disks)	$1,850	$1,595
Cost/1000 bytes	$1.18	$4.20
The PIED PIPER value	1/4 the cost per Kilobyte of storage	
The user advantage:		
Storage available when using Perfect Writer	560K	190K

PIED PIPER advantage - 295% more available user space on each diskette!

Video Display:

The PIED PIPER allows the use of any video monitor with a 'composite video' input. (This excludes a few color monitors.) The recommended method of viewing the computer 80x24 output is with a video monitor.

Choose the monitor that is right for you, large/small; green/amber. With the PIED PIPER you won't be stuck with a small, hard-to-see screen. And you won't have to lug it around with you if it is not necessary. Buy two monitors - one for the office, one for home.

TV Display:

Use the PIED PIPER just about anywhere because it has an integral connector for a standard R.F. modulator for use with with a television set.

Just think, the PIED PIPER can be used with several different types of displays (TV, video monitor, etc.), so you don't have to carry a bulky monitor while you're traveling. A special PIED PIPER program is included so that standard 80 column displays can be viewed, 40 columns at a time. The program has a horizontal scrolling feature to view 80 columns of text on a regular television screen.

Printer Port:

The PIED PIPER has a standard parallel printer port built in. Use it with high speed dot matrix printers or letter quality printers simply by plugging them into the PIED PIPER. STM supplies the cable to ensure trouble-free printing for the user.

IN THIS SECTION:

- Second Floppy Drive
- Serial Board
- STD Bus Interface

Serial Board with two RS232C ports: This serial board option has dual RS232C ports. Each port has a DB25 pin connection for use with standard serial type peripherals such as printers, plotters and modems. This serial board uses one of the expansion board locations in the PIED PIPER.

1 Mbyte drive

The PIED PIPER was designed with mass storage expansion in mind. A second floppy drive is easily connected by installing a new cable and adding a back plate. The power lead is already in place.

The back plate permits rapid plug-in and removal of both the 1/0 interface as well as the power supply.

With 2 drives, the user now has 1.6 Mbytes of online storage.

STD Compatible Bus:

The edge connector will allow the PIED PIPER access to the outside world.

More information is available in the technical section for users who wish to know the I/O positions on the edge card.

See page VII, 51-52.

IN THIS SECTION:

- PIED PIPER Service
- List of Xerox Service Centers
- PIED PIPER Limited Warranty
- PIED PIPER Extended Warranty
- Initiating the Warranty
- Sample Warranty Card

PIED PIPER™

PIED PIPER WARRANTY AND SERVICE

STM offers a complete service program that includes:

-	Limited Warranty	90 days from date of purchase
-	Extended Warranty (optional)	1 year - starting when the 90 day limited warranty expires.

Maintenance is performed in authorized locations by qualified personnel. Facilities are conveniently located across the nation.

Nationally/Locally	Xerox Service Centers (listed on the following pages)
Locally	Authorized STM Service Centers

With this service program for your PIED PIPER, you are assured of quality, reliable repairs locally or nationwide.

PIED PIPER™

HOW TO ACTIVATE THE PIED PIPER WARRANTY

We at STM Electronics have endeavored to make the process of activating the PIED PIPER warranty as simple, yet complete as possible in order to protect both the customer and the dealer.

When the PIED PIPER is sold, simply follow these step by step instructions to activate the end-user's warranty.

1. Complete the sales transaction first!
2. Remove the warranty registration card from the sleeve located on the outside of the PIED PIPER box.
3. Punch out the purchase date on the silver registration label, piercing the registration card.
4. Complete: (a) PIED PIPER serial number blank; (b) Dealer information section; (c) STM software serial numbers; (d) Extended warranty information section (if applicable).
5. Complete customer name, address and phone number section.
6. Customer should read the end-user agreement acknowledgment and sign on the blank line where indicated by "end-user signature."
7. Customer should complete the personal information section.
8. Dealer should complete the Inspection Report on the reverse side of the card. Note: only check boxes if the module is defective.
9. Review all sections to ensure that the card has been completely prepared and then separate and distribute the form as indicated.
10. Affix the silver warranty registration label to the PIED PIPER as indicated in the picture on the warranty card.
11. Mail the warranty card to STM Electronics.

PIED PIPER™

PIED PIPER/XEROX SERVICE CENTERS

State	Service Center	Address
Alabama	Birmingham	167-A Citation Court Birmingham, AL 35209 205-954-1280
Arizona	Phoenix	2109 S. 48th Street, Suite 101 Tempe, AZ 85282 602-967-1922
California	Alhambra	614 South Marengo Alhambra, CA 91803 213-278-0174
	Anaheim	232 W. Cerritos Avenue Anaheim, CA 92805 714-776-8143
	Carson	20630 Leapwood, Suite E Carson, CA 90746 213-516-6650
	Chatsworth	20802 Plummer Street Chatsworth, CA 91311 213-709-0226
	Oakland	1981 Adams Street San Leandro, CA 94577 415-635-9300
	Sacramento	4247 S. Market Court Sacramento, CA 95834 916-920-2275
	San Diego	7454 Ronson Road, Suite N San Diego, CA 92111 619-569-1212
	San Francisco	1555 Burke Avenue, Suite B San Francisco, CA 94124 415-821-7719
	Sunnyvale	540 Weddel Drive, #6 Sunnyvale, CA 94086 408-734-2540

PIED PIPER™

State	Service Center	Address
Colorado	Denver	8200 East Pacific Place, Suite 201 Denver, CO 80231 303-696-8966
Connecticut	Hartford	593 Farmington Avenue Hartford, CT 06105 203-236-2381
Delaware	Wilmington	301 Willowbrook Lane Westchester, PA 19380 215-431-0533
Florida	Ft. Lauderdale	1500 N.W. 62nd Street, #502 Ft. Lauderdale, FL 33308 305-491-3202
	Jacksonville	3035 Powers Avenue, Unit #4 Jacksonville, FL 32207 904-731-7218
	Miami	6908 NW 72nd Avenue Miami, FL 33166 305-887-2711
	Orlando	716 North Lake Boulevard Altamonte Springs, FL 32701 305-830-8109
	Tampa	6201 Johns Road, Suite 6 Tampa, FL 33614 813-886-0779
Georgia	Atlanta	2215 Perimeter Park Dr., Suite 10 Atlanta, GA 30341 404-458-1016
Hawaii	Honolulu	627 South Street, Suite 104 Honolulu, HI 96813 808-526-0885
Iowa	Des Moines	700 E. 4th Street Des Moines, IA 50306 515-282-8700

State	Service Center	Address
Illinois	Chicago Loop	165 North Canal Street Chicago, IL 60606 312-559-9440
	Elk Grove Village	2216 Landmeier Road Elk Grove Village, IL 60007 312-437-3180
	Lombard	436A Eisenhower Lane Lombard, IL 60148 312-953-1113
	Springfield	2036 S. MacArthur Springfield, IL 62704 217-523-1007
Indiana	Indianiapolis	5335 West Minnesota Street Indianapolis, IN 46241 3187-241-2888
Kansas	Kansas City	6383 West 110th Street Overland Park, KS 66211 913-381-9819
	Wichita	7804 East Funston Cherry Creek Business Park Wichita, KS 67202 316-685-4731
Kentucky	Louisville	10308 Bluegrass Parkway Louisville, KY 40223 502-499-7224
Louisiana	Baton Rouge	10466 Airline Highway, Suite K Baton Rouge, LA 70816 504-291-5974
	New Orleans	550 Wholesalers Parkway, Suite F Harahan, LA 70123 504-733-1201

PIED PIPER™

State	Service Center	Address
Massachusetts	Boston	248 W. Cummings Park Woburn, MA 01801 617-938-0845
	Braintree	190 Forbes Road Braintree, MA 02184 617-848-5750
Maryland	Baltimore	100 Lakefront Drive Hunt Valley Bus. Com. Hunt Valley, MD 21030 301-667-8711
	Rockville	12288 H. Wilkens Avenue Rockville, MD 20852 301-468-8870
	Washington	9730A-1 George Palmer Highway Lanham, MD 20801 301-459-3973
Michigan	Detroit	1270 Rankin, Suite C Troy, MI 48084 313-583-2935
	Lansing	6810 South Cedar, Suite 7 Lansing, MI 48910 517-694-3350
Minnesota	Minneapolis	3650 Hazelton Road Edina, MN 55435 612-920-4472
Missouri	St. Louis	11984 Dorsett Road St. Louis, MO 63141 314-991-2106
Mississippi	Jackson	870 Foley Street Jackson, MS 39202 601-948-6302

State	Service Center	Address
Nebraska	Omaha	11129 Mill Valley Road Omaha, NE 68154 402-493-0387
North Carolina	Charlotte	1838 G Interstate 85 S. Carolina Center Charlotte, NC 28208 704-399-1523
	Raleigh	5225 North Boulevard #1 N. Commerce Center Raleigh, NC 27604 919-876-1610
New Jersey	Bergen	300-1B Route 17 Lodi, NJ 07644 201-777-4441
	Central Jersey	145 Algonquin Parkway Whippany, NJ 07981 201-428-1275
	Princeton	248 US Rt. 1 North Bldg. 1 Monmouth Junction, NJ 08852 201-329-2050
New Mexico	Albuquerque	5659 Kircher Boulevard, Suite D Albuquerque, NM 87109 505-344-3563
New York	Albany	Pine West Plaza One Washington Avenue Ext. Albany, NY 12205
	Buffalo	198 Sugg Road Cheektowaga, NY 14227 716-634-2993
	Long Island	3000 Marcus Avenue, Suite 1-E8 Lake Success,NY 11042 516-437-1134

PIED PIPER™

State	Service Center	Address
New York	Manhattan	405 Lexington Avenue Chrysler Building New York, NY 10017 212-697-2190
	Rochester	333 Metro Park Rochester, NY 14623 716-424-4010
	Syracuse	7150 Henry Clay Boulevard Liverpool, NY 13088 315-451-7420
	Tarrytown	5 Westchester Plaza Elmsford, NY 10523 914-592-4454
Ohio	Akron	2650 S. Arlington Road Akron, OH 44319 216-644-3251
	Cincinnati	4814 Interstate Drive cincinnati, OH 45246 513-874-0884
	Cleveland	Technology Plaza 5267 East 98th Street Cleveland, OH 44125 216-587-1546
	Columbus	3711 Corporate Drive Columbus, OH 43229 614-895-3033
Oklahoma	Oklahoma City	2122 South Meridian Oklahoma City, OK 73108 405-682-5030
	Tulsa	4725A South Memorial Drive Tulsa, OK 74145 918-665-0811

PIED PIPER™

State	Service Center	Address
Oregon	Portland	10110 S.W. Nimbus Avenue, B-9 Tigard, OR 97223 503-684-1152
Pennsylvania	Harrisburg	806 S. 29th Street Harrisburg, PA 17111 717-564-2602
	King of Prussia	1006 W. 8th Avenue, Suite C King of Prussia, PA 19409 215-337-4486
	Philadelphia	9140 Academy Road, Suite H&I Philadelphia, PA 19136 215-331-0999
	Pittsburgh	601 Holiday Drive Pittsburg, PA 15220 412-921-8202
	Westchester	301 Willowbrook Lane Westchester, PA 19380 215-431-0533
Tennessee	Memphis	1835 Nonconnah Blvd., Suite 143 Memphis, TN 37132 901-346-2211
	Nashville	1854 Airlane Drive Nashville, TN 37210 615-883-5102
Texas	Austin	7950 Anderson Square, #112 Austin, TX 78758 512-451-6263
	Dallas	1525 W. Mockingbird Lane, Suite 104 Dallas, TX 75235 214-630-6647
	Ft. Worth	3273 Crabtree Street Ft. Worth, TX 76111 817-626-8243

PIED PIPER™

State	Service Center	Address
Texas	Houston #1	7280 Wynnwood, Suite 220 Houston, TX 77008 713-862-1784
	Houston #2	3642 Westchase Drive Houston, TX 77042 713-789-3070
	San Antonio	2411 Northeast Loop 410, Suite 112 San Antonio, TX 78217 512-655-0085
Utah	Salt Lake City	3697 W. 1987 S. Salt Lake City, UT 84104
Virginia	Fairfax	2731B Prosperity Avenue Fairfax, VA 22031 703-698-7477
	Richmond	8707 West Broad Street Richmond, VA 23229 804-747-0275
	Tidewater	1448 Air Rail Avenue Virginia Beach, VA 23455 804-464-4752
Washington	Seattle	266 S.W. 43rd Avenue Renton, WA 98055 206-251-9155
Wisconsin	Milwaukee	2995 South Moreland New Berlin, WI 53151 414-784-3690
West Virginia	Charleston	523 Central Avenue Charleston, WV 25302 304-342-8015

THIS SECTION CONTAINS A SET OF PIED PIPER TECHNICAL DATA SHEETS

PIED PIPER™

This section contains explanations of the PIED PIPER specifications and other technical information:

Section	Page
Processor	1 - 2
Memory	3 - 8
Keyboard	9 - 18
Display Capability	19 - 31
Printer Port	32 - 34
Floppy Disk Drive	35 - 49
Expansion	50 - 54
Specifications	55

HARDWARE

1.0 The Microprocessor

Model	: Z80A CPU Microprocessor
Manufacturer	: Zilog, Inc.
No. of Instructions	: 158
Addressing Modes	: 10
Accumulator	: 2 (A,A')
General Purpose Register	: 12 (BC,DE,HL,BC',DE',HL')
Index Registers	: 2 (IX,IY)
Other Registers	: Stack pointer (SP) : Interrupt Register (I) : Refresh Register (R) : Program Counter (PC) : Flag Register (F,F')
Status Flags	: S (Sign) : Z (Zero) : P/V (Parity or Overflow) : C (Carry) : N (Add/Subtract) : H (Half Carry)
Other Flags	: IFF1, IFF2 (Interrupt Enable) : IMFa, IMFb (Interrupt Mode)
Interrupts	: 1 Non-maskable : 1 Maskable
Interrupt Mode	: 3
Addressing Range	: 64K Locations
Address Bus	: 16 bits, parallel
Data Bus	: 8 bits, parallel
Voltage	: Single +5V
Clock Frequency	: 4.000 MHz

The processor gets its timing signal 4.000 MHz clock from the clock generator circuit which uses an 8.000 MHz crystal as its time basis. Other clock timing like the 2 MHz and 1 MHz clock for peripheral controllers are obtained by using a counter 74LS161 to scale down the system clock.

The microprocessor has a 16-bit address bus and an 8-bit data bus. The address bus lines AB0-AB7 are buffered by a buffer 74LS244, and the data bus lines DB0-DB7 are buffered by a tri-state buffer 74LS245.

The BUSRQ, HALT/,NMI/,INT/ and WAIT/ are held high by 1K Ohm resistors to +5V. I/O write and read signals are decoded by logic gates using signals IORQ/, WR/ and RD/ from the CPU.

The RFSH/ signal is used by the Memory Refresh Circuitry to provide the signal necessary for dynamic memory refreshing.

Memory Organization

The PIED PIPER has a total memory capacity of 72K bytes. These include the following:

- 64K RAM system memory
- 4K bootstrap ROM
- 2K RAM display memory
- 2K character generator ROM

Only the bootstrap ROM and the system memory uses the Z80A processor memory address lines. The display memory is accessed through I/O addresses, and the character generator ROM is accessed solely by the video display controller.

Although the bootstrap ROM is only 4K bytes in size, the PIED PIPER is capable of accommodating ROM of up to 16K bytes in size. Both the system memory and the bootstrap ROM share the memory addresses from 0000 hex to 7FFF hex, but only one will be activated at any given time. When the ROM is enabled, accesses to memory address 0000 to 7FFF hex will be directed to the ROM. When the ROM is disabled, accesses will be directed to the system RAM memory.

The bootstrap ROM contains hardware initialization procedures, self-test diagnostics, and bootstrap routine for bringing in the first sector of the first track on the floppy disk. The content of this ROM is copied to RAM starting from location 0F000 hex after some preliminary self test. The ROM is then disabled, and the remaining self tests plus the bootstrap procedure are executed from the RAM area.

```
0000H
                Page 0, reserved for CP/M
00FFH
0100H           Transient Program Area
                        (TPA)


0CBFFH
0CC00H          Console Command Processor
                        (CCP)

0D3FFH
0D400H          Basic Disk Operating System
                        (BDOS)

0E1FFH
0E200H          Basic Input Output System
                        (BIOS)

0F4FFH
0F500H          Reserved Area for Option
                      Card Programs

0FAFFH
0FB00H          Interrupt Vectors
0FB0FH
0FB10H          Interrupt Handling Routines
                        +
                Disk Input/Output Routines
                        +
                Reserved Data Area
                        +
                Jump Vectors for Useful
                     Routines
0FFFFH
```

ROM Memory

The PIED PIPER Boot Utility Program is stored on a 32K bits PROM which occupies memory address from 0000H to 0FFFH. The circuit is designed to accommodate ROM of up to 128K bits in size which will then occupy memory address from 0000H to 3FFFH.

In order to fully utilize the 64K bytes RAM address capability for the system, both the RAM and ROM will occupy the same memory address from 0000H to 7FFFH. However, only one will be activated at any given time. The ROM SELECT flag dictates which of the two is to be activated. If the ROM SELECT flag is set, the ROM will be enabled, and if it is off, then RAM will be selected. The RAM address from 8000H to FFFFH is independent of the flag and is accessible all the time.

When the system is reset, the ROM SELECT flag is set by the RESET line. Hence the RAM from address 0000H to 7FFFH is disabled and ROM memory is activated. The stored program in the ROM will then start loading the CP/M Operating System from the system diskette onto the RAM. When completed, the ROMSEL/ bit is set high, and a read Status Register instruction will be issued which will set off the ROM SELECT flag. Thereafter, the lower portion RAM will resume its memory address, and we will get the full 64K bytes of memory storage.

ROM Size Selection Jumper

The jumper JU installed on the board can be used to select the ROM size that can be installed in the ROM socket.

When jumper to JU2 is connected to +5V, an 8K x 8 bit ROM can be installed in the socket. When trace to JU2 is cut and jumper to JU1 is connected to A13, a 16K x 8 bit ROM can be used. The existing board is with JU1 connected to A13.

ROM SOCKET PINOUT

+5V	1	28	+5V	
A12	2	27	+5V	*JU2 +5V
A07	3	26	---------*	
A06	4	25	A08	*JU1 A13
A05	5	24	A09	
A04	6	23	A11	
A03	7	22	OE/	
A02	8	21	A10	
A01	9	20	CE/	
A00	10	19	D07	
D00	11	18	D06	
D01	12	17	D05	
D02	13	16	D04	
GND	14	15	D03	

RAM Memory

The PIED PIPER uses eight 64K x 1 bit Dynamic RAMs for its 64K bytes memory storage. The memory address is from 0000H to FFFFH.

The address for RAM is provided by two address multiplexers which give the low and high address byte to RAMs, depending on the status of Row Address Strobe RAS/ and the Column Address Strobe CAS/.

The data lines are directly tied to the system data bus, and data read/write mode is selected by the write enable line WE/. A logic high on the WE/ selects the read mode, and a logic low selects the write mode.

The Dynamic RAMs are automatically refreshed during the instruction fetch cycles. The CAS/ line is set high when the refresh signal line RSH/ is low to avoid any data output during refresh. When RFSH/ and MREQ/ are low, the RAS/ line takes the lower system address byte as a refresh address and causes all bits in each row to be refreshed.

Display Memory

The video display controller uses information in the display memory to generate its display. The value stored in a display memory location controls the character block to be displayed on the monitor. The value is a regular 7-bit ASCII value. The most significant bit denotes high intensity or low intensity when the highlight mode is selected. If the reverse video mode is selected, the display will be in reverse video or regular video, depending on the value of the most significant bit.

The display memory address starts from 0000 hex to 07FF hex. The screen start registers contain the starting address of memory that corresponds with the top left hand corner of the display screen. The controller is smart enough to automatically wrap around the display memory so that the screen start address can be changed dynamically. As an example, the PIED PIPER uses a 24 by 80 display and the display buffer starting address is initialized to 0080 hex. The number of memory cells from 0080 hex to 07FF hex is 1920, which is equal to 24 times 80. If the screen start registers contain 0120 hex, the memory location at this address will represent the top left hand corner of the display. Due to the wrap around nature, memory address 011F hex will represent the lower right hand corner of the display.

The cursor registers contain the memory address of the current cursor position on the monitor. For example, if the screen start address is 0120 hex, and the cursor is on the first column of the third line, the cursor registers will contain the address 01C0 hex.

The pointer registers are used most of the time for initializing a portion of the display memory to a certain value. This is accomplished by using one of the controller commands to write from the cursor position to the pointer position. Continuing the above example, to blank out the third line of the display, all one has to do is to modify the pointer registers to equal to the cursor registers plus 80 (for 80 columns), and then issue the "write cursor to pointer" command to the command register.

Keyboard

The keyboard is one of the main communication tools for the user on the PIED PIPER. All user inputs are through the keyboard.

The PIED PIPER keyboard has 61 keys. Except for a few special keys, the keyboard resembles a full sized typewriter keyboard.

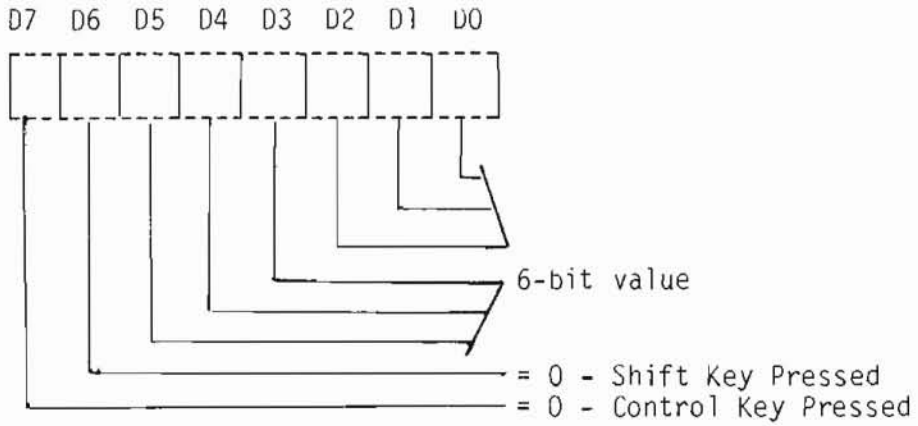
Except for the FUNCT, CTRL, SHIFT, and CAPS LOCK keys, which do not generate a code by themselves, all other keys generate a 6-bit value. The CTRL, SHIFT, and FUNCT keys contribute the remaining 2 bits to form an 8-bit code. This 8-bit code is accessible through the data register.

Although there is no repeat key on the keyboard, by pressing a key without releasing it for more than one second, the key is duplicated automatically until the key is released. This auto repeat feature does not work with the FUNCT key. This feature is implemented by software and is described in more detail in a later section.

Addressing

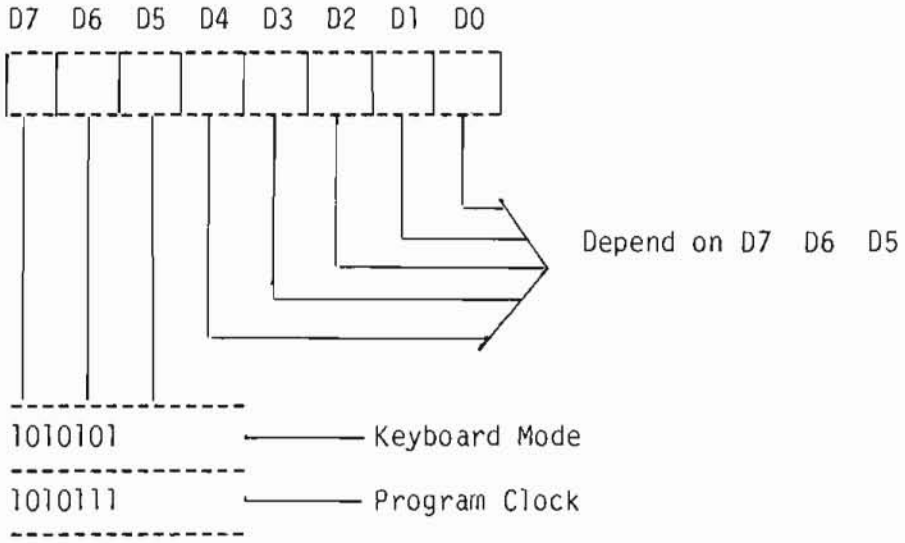
Data Register:	08H
Command Register:	09H - Write only
Status Register:	09H - Read only

Data Register - 08H



Function Key Pressed ==e D7 and D6 = 0

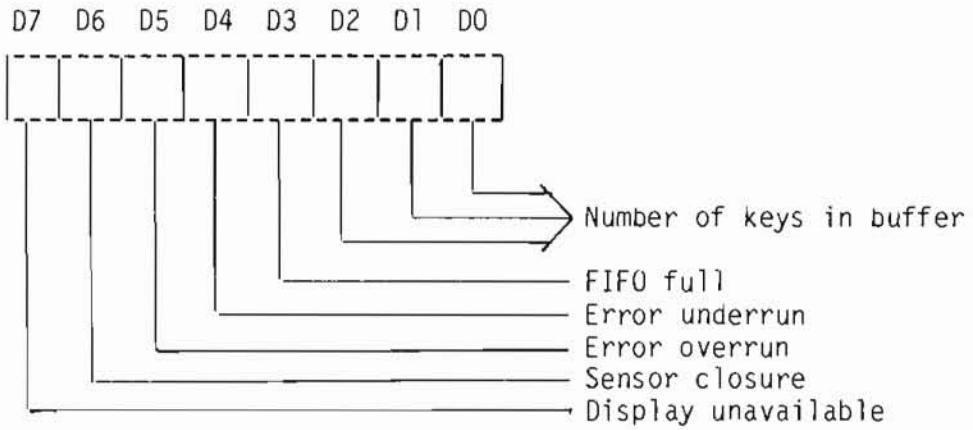
Command Register - 09H



The command register allows for initialization of the keyboard mode as well as initialization of the program clock for the scan cycle.

The program clock is the internal frequency for the scan and debounce time. To obtain an internal frequency of 100 KHz, with an incoming signal of 1 MHz, the prescaler value defined by the least significant five bits will be 01010, i.e., it is necessary to divide the incoming clock by 10.

Status Register - 09H



Initialization example

To initialize the keyboard for a 2-key lockout and 50 KHz operating frequency:

```
LD   A,00000000B    : SET ENCODED SCAN &
OUT  09H,A          : 2 KEY LOCKOUT
LD   A,00101010B    : SET UP PROGRAM CLOCK
OUT  09H,A
```

Auto Repeat

When a key is pressed but not released, the decoding circuitry only reports a single key pressed event. In order to implement the auto repeat feature, the decoding circuitry must be tricked into thinking that the key has been released and pressed again. To accomplish this, the keyboard scan must be disabled and then enabled again to simulate a key release and press action. The timer is used extensively in controlling the frequency of the above simulation.

Decoding

The 8-bit value from the data register is used to translate the key pressed into the appropriate ASCII value of the key before the operating system retains control. The non-translated value can be obtained directly from the data register.

Although the CTRL, SHIFT and FUNCT keys alter the 8-bit value of the data register, the same does not apply for the CAPS LOCK key. The latter key only alters the translated value. CAPS LOCK causes all lower case alphabetic values to be transformed into upper case.

The CTRL key works with all alphabetic letter keys, plus the following:

- shift 2
- shift 6
- [
-]
- \
- shift -

All other keys are translated as if the CTRL key is not pressed.

The SHIFT key works the same way as on a typewriter; i.e., letter keys are capitalized, and special characters above the number keys are produced.

The FUNCT key works with all alphabetic letter keys, the number keys except 2 and 6, and the arrow keys.

The numeric functions and the arrow functions are reserved for the horizontal scrolling under the TV display and also for display manipulation under Liquid Crystal Display option. The alphabetic letter functions can be decoded by calling the CP/M CONIN BDOS function. The translated value of a function key has the most significant bit set.

Value of keys before translation.
All values are in hexadecimal.

Key	Alone	SHIFT	CTRL	FUNCT
ESC	C0	80	40	00
1 !	C8	88	48	08
2 @	C1	81	41	01
3 #	C9	89	49	09
4 $	CA	8A	4A	0A
5 %	C2	82	42	02
6 ^	C3	83	43	03
7 &	CB	8B	4B	0B
8 *	CC	8C	4C	0C
9 (	C4	84	44	04
0)	C5	85	45	05
- _	CD	8D	4D	0D
= +	CE	8E	4E	0E
£ ~	C6	86	46	06
DELETE	C7	87	47	07
BREAK	CF	8F	4F	0F
TAB	D0	90	50	10

Value of keys before translation.
All values are in hexadecimal.

Key	Alone	SHIFT	CTRL	FUNCT
Q	D8	98	58	18
W	D9	99	59	19
E	D1	91	51	11
R	D2	92	52	12
T	DA	9A	5A	1A
Y	DB	9B	5B	1B
U	D3	93	53	13
I	D4	94	54	14
O	DC	9C	5C	1C
P	DD	9D	5D	1D
[{	D5	95	55	15
] }	D6	96	56	16
\ |	DE	9E	5E	1E
BACKSPACE	DF	9F	5F	1F
A	E1	A1	61	21
S	E9	A9	69	29
D	EA	AA	6A	2A
F	E2	A2	62	22
G	E3	A3	63	23

Value of keys before translation.
All values are in hexadecimal.

Key	Alone	SHIFT	CTRL	FUNCT
H	EB	AB	6B	2B
J	EC	AC	6C	2C
K	E4	A4	64	24
L	E5	A5	65	25
; :	ED	AD	6D	2D
' "	EE	AE	6E	2E
RETURN	E6	A6	66	26
LINE FEED	E7	A7	67	27
Z	F9	B9	79	39
X	F1	B1	71	31
C	F2	B2	72	32
V	FA	BA	7A	3A
B	FB	BB	7B	3B
N	F3	B3	73	33
M	F4	B4	74	34
, <	FC	BC	7C	3C
. >	FD	BD	7D	3D
/ ?	F5	B5	75	35
←	F6	B6	76	36
→	FE	BE	7E	3E
SPACE BAR	F8	B8	78	38

The Keyboard

The keyboard controller is built around the Intel 8279 programmable keyboard controller and inferfaces with the keyboard via the connecting cable at Connector J13.

The controller rapidly scans through the column lines CL0-CL7 of the key matrix on the keyboard. Its row values from the returned lines RL0-RL7 are latched and scanned for key closure in that row. When a low is detected in any of RL0 to RL7 lines, a key closure is found and a debounce circuit is activated to check if it is a proper key switch depression. If the closure is shorter than 20 msec. it is regarded as a bounce, and the controller looks for another key closure. Otherwise, the key position is returned together with the status of the CONTROL and SHIFT lines and stored into the controller's character buffer.

When a key closure is detected and lasts for more than 2 seconds, the keyboard is disabled by setting off the KBREL line and then reenabled again to check for key depression. If a key closure is detected and the key value is the same as that previously stored in the controller's character buffer, the key is placed in the auto repeat mode. The KBREL line is disabled and reenabled every 0.05 seconds to generate a multiple key closure effect. This process is repeated until the key is released. If no key or a different key closure is detected at any time after the KBREL line is reenabled, the keyboard scan cycle is repeated.

The Keyboard Connector J13

This is a 24-pin male connector which is used to connect with the built-in typewriter-like keyboard assembly. The signal descriptions for the connector are as follows:

Signal Name	Signal Flow	functional Description
CL0-CL7	Output	Column scan lines which are used to scan the key switch closure. SL7 is the most significant column line number.
RL0-RL7	Input	Return line inputs. These lines should be pulled high until a switch closure in the row pulls it to low. RL7 is the most significant row number.
CNTL/	Input	This line should be low when "CTRL" or "FUNCT" key is depressed.
SHIFT/	Input	This line should be low when "SHIFT" or "FUNCT" key is depressed.

KEY DEPRESSION	CNTL/	SHIFT/
FUNC	Low	Low
CTRL	Low	High
SHIFT	High	Low
NIL	High	High

CAPLK/	Input	This line should be low when capital lock key "CAPS LOCK" is depressed.
C00/-C01	Output	Drive select indicators. C00/ is low when Drive 1 is selected. C01/ is low when Drive 2 is selected.
SPK	Output	Audio signal output to speaker mounted on the PCB board.

The Keyboard Connector J13 Pin Assignments

Pin No.	Signal Name
1	CNTL/
2	CAPLK/
3	SHIFT/
4	RL0
5	RL1
6	RL2
7	RL3
8	RL4
9	RL5
10	RL6
11	CL0
12	RL7
13	CL1
14	CL2
15	CL3
16	CL4
17	CL5
18	CL6
19	CL7
20	Signal Ground
21	C00/
22	C01/
23	+5V
24	SPK

Video Display

The video display is another vital communication tool for the user on the computer.

The display memory is independent of system memory. Transfer of data between the CPU and the display buffer memory is controlled by the Programmable Video Timing Controller. The video display is a character block display and has the following capabilities:

- 8 x 9 or 7 x 9 character block
- White on black or black on white displacy
- High intensity or mono-intensity
- 80 or 40 columns display
- 24 or 25 lines
- Reverse video
- Line or block cursor
- Blink or no-blink cursor

The video display controller is an intelligent controller with many features in addition to the ones described above. Please refer to the Signetics 2672 Programmable Video Timing Controller Application Notes for more detail.

Addressing

Initialization Register:	00H
Command Register:	01H
Status Register:	01H
Screen Start Registers:	02H - low byte 03H - high byte
Cursor Registers:	04H - low byte 05H - high byte
Pointer Registers:	06H - low byte 07H - high byte
Data Registers:	0DH - input 1CH - output

Initialization

Initialization of the video display chip involves selecting the video display mode through the mode register and also supplying the values to the 11 initialization registers.

The normal start up condition of the video display chip is: 7 x 9 character block, white on black screen, 2K character set, high intensity, and 80 columns display.

The cursor is a non-blink block character. The display is 24 lines.

Initialization Registers - 00H

There are 11 initialization registers (IR0 - IR10) which are accessed sequentially via a single address. The controller maintains an internal pointer to these registers which is incremented after each write at this address until the last register (IR10, the split screen register) is accessed.

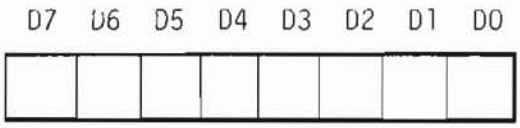
The following values are for the setting as described in section 5.2.

IR0	0	1	0	0	0	1	0	0 -- 44H
IR1	0	0	1	1	0	0	1	0 -- 32H
IR2	0	0	0	0	1	1	1	0 -- 0EH
IR3	0	1	1	0	0	1	1	0 -- 66H
IR4	0	0	0	1	0	1	1	1 -- 17H
IR5	0	1	0	0	1	1	1	1 -- 4FH
IR6	0	0	0	0	1	0	0	0 -- 08H
IR7	0	0	0	0	1	0	0	1 -- 09H
IR8	1	0	0	0	0	0	0	0 -- 80H
IR9	0	0	0	1	0	0	0	0 -- 10H
IR10	1	0	0	0	0	0	0	0 -- 80H

Command Register 01H

The video display controller commands are divided into two classes: the instantaneous commands, which are executed immediately after they are invoked, and the delayed commands which may require a delay for a blanking interval prior to their execution.

Command Formats



Instantaneous Commands

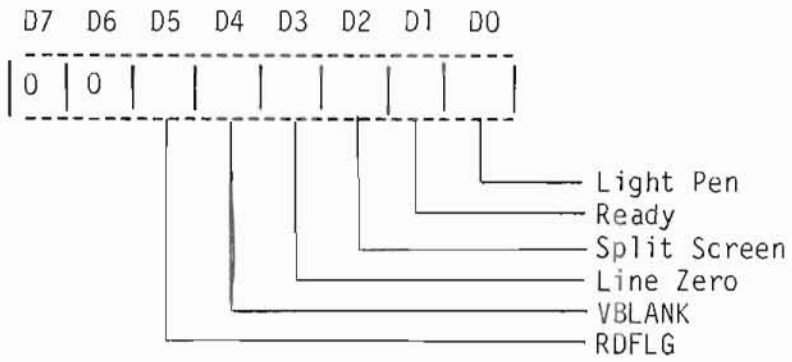
0	0	0	0	0	0	0	0	-	Master Reset
0	0	0	1	V	V	V	V	-	Load initialization register pointer with value V (V = 0 to 10)
0	0	1	d	d	d	1	0	-	Disable light pen (*)
0	0	1	d	d	d	1	1	-	Enable light pen (**)
0	0	1	d	1	N	d	0	-	Display off. Float DADD bus if N = 1 (*)
0	0	1	d	1	N	d	1	-	Display on. Scan line (N = 0) or next field (N = 1) (**)
0	0	1	1	d	d	d	0	-	Cursor off (*)
0	0	1	1	d	d	d	1	-	Cursor on (**)
0	1	0	N	N	N	N	N	-	Reset interrupt/status Bit reset where N - 1
1	0	0	N	N	N	N	N	-	Disable interrupt. Disable where N = 1
0	1	1	N	N	N	N	N	-	Enable interrupt. Enables interrupts and resets the corresponding interrupt or status bits where N = 1.

(*) Any combination of these three commands is valid.
(**) Any combination of these three commands is valid.
d = Don't care.

Delayed Commands

1	0	1	0	0	1	0	0	-	Read at pointer address
1	0	1	0	0	0	1	0	-	Write at pointer address
1	0	1	0	1	0	0	1	-	Increment cursor address
1	0	1	0	1	1	0	0	-	Read at cursor address
1	0	1	0	1	0	1	0	-	Write at cursor address
1	0	1	0	1	1	0	1	-	Read at cursor address and increment address
1	0	1	0	1	0	1	1	-	Write at cursor address and increment address
1	0	1	1	1	0	1	1	-	Write from cursor address to pointer address

Status Register - 01H



RDFLG - A "zero" indicates that the controller is currently executing the previously issued command. A "one" indicates that the controller is ready to accept a new command.

VBLANK - This indicates the beginning of a vertical blanking interval. It is set to a "one" at the beginning of the first scan line of the vertical front porch.

Line Zero - It is set to a "one" at the beginning of the first scan line (line 0) of each active character row.

Split Screen - This bit is set when a match occurs between the current character row number and the value contained in the split screen interrupt register, which is set at initialization time.

Ready - Certain commands affect the display and may require the controller to wait for a blanking interval before enacting the command. This bit is set to "one" when execution of the command is completed.

Light Pen - A "one" indicates that a light pen hit has occurred and that the contents of the light pen register have been updated.

Data Registers - ODH (Read) and 1CH (Write)

The data registers are used for storing and retrieving data to and from the display memory. These registers must be used together with one of the delayed commands.

Examples:

1. Clear display to blank at start up.

```
NOTRDY:

    IN    A,01H:          GET STATUS
    AND   20H:            CHECK IF READY
    JR    Z,NOTRDY:       REPEAT IF BUSY
    LD    A,20H:          SET TO INITALIZE TO BLANKS
    OUT   1CH,A:          SEND TO DATA REGISTER
    LD    A80H:           INITIALIZE CURSOR REGISTERS
    OUT   04H,A:          TO TOP LEFT CORNER OF SCREEN
    LD    A,00H
    OUT   05H,A
    LD    A,0FFH:         INITIALIZE POINTER REGISTERS
    OUT   06H,A:          TO BOTTOM RIGHT CORNER
    LD    A,07H:          OF SCREEN
    OUT   07H,A:
    LD    A,10111011B
    OUT   01H,A:          WRITE CURSOR TO POINTER
```

2. Read back content of display memory at cursor position.

```
    LD    A,10101100B:    READ AT CURSOR
    OUT   01H,A

NOTRDY:
    IN    A,01H:          GET STATUS
    AND   20H:            CHECK IF READY
    JR    Z,NOTRDY:       REPEAT IF BUSY
    IN    A,0DH:          READ DATA FROM DATA REGISTER
```

Terminal Emulation

The video display as handled by the CP/M CONOUT BDOS function emulates a Hazeltine 1500 terminal. To configure application programs such as Wordstar, which makes use of screen functions, select the Hazeltine 1500 as the terminal during the installation procedure.

All functions of the Hazeltine 1500 are emulated, except the following:

- Field Tab
- Block Mode

In addition to the above functions, the following functions are added:

Turn cursor ON	Lead-in, SOH	(7EH,01H)
Turn cursor OFF	Lead-in, STX	(7EH,02H)
Turn display ON	Lead-in, ETX	(7EH,03H)
Turn display OFF	Lead-in, EOT	(7EH,04H)
Graphic character	Lead-in, RS, char	(7EH,1EH)

The graphic character function allows application programs to utilize the special table-drawing character set.

Reverse Video

Reverse video is accomplished by setting the reverse video bit in the mode register.

Programming example

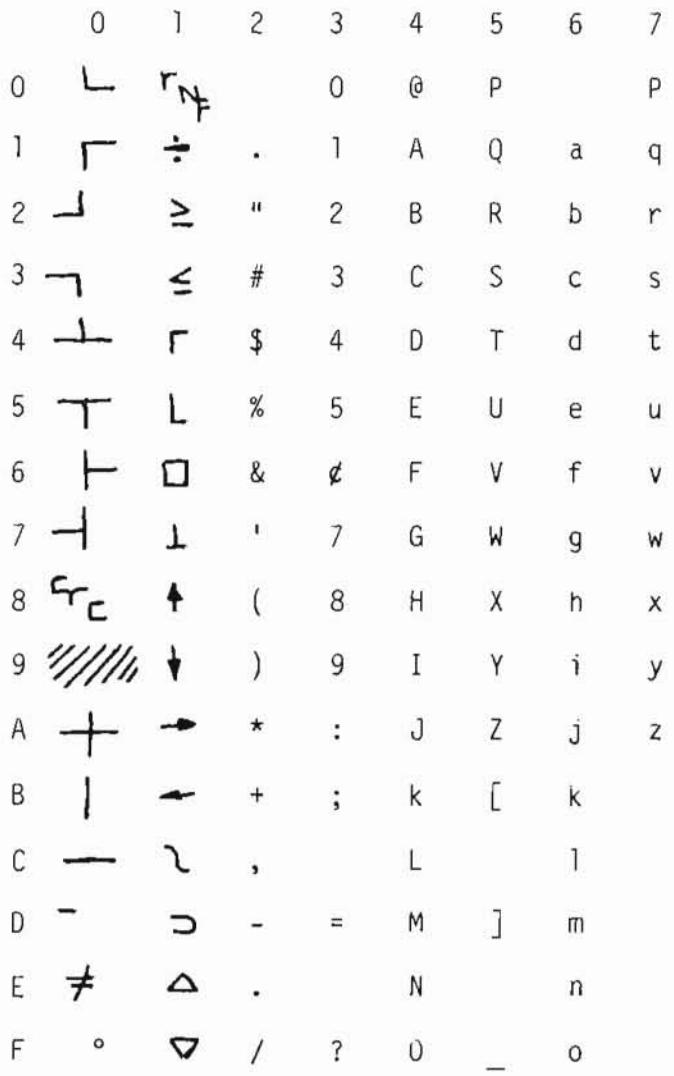
```
LD    A,(OFFEOH):       GET CURRENT VALUE
RES   2,A:              RESET HIGH INTENSITY
SET   1,A:              SET REVERSE VIDEO
LD    (OFFEOH),A:       SAVE CHANGED VALUE
OUT   10H,A:            UPDATE MODE
```

Character Set

Basically the normal character set as found in most terminals is supported. Exceptions are:

- The British pound sign "£" replaces the single back quote " ".
- Graphic characters for drawing table are included.

When displaying, the 7-bit ASCII value of a character is supplied to the Video Display Controller. The most significant bit is used to indicate highlight or reverse video, depending on the mode selected.



	0	1	2	3	4	5	6	7
0				0	@	P		P
1		÷	.	1	A	Q	a	q
2		≥	"	2	B	R	b	r
3		≤	#	3	C	S	c	s
4			$	4	D	T	d	t
5			%	5	E	U	e	u
6			&	¢	F	V	f	v
7			'	7	G	W	g	w
8			(	8	H	X	h	x
9			)	9	I	Y	i	y
A			*	:	J	Z	j	z
B			+	;	k	[	k	
C			,		L		l	
D			-	=	M	]	m	
E	≠		.		N		n	
F	°		/	?	O	_	o	

The character generator ROM contains information required by the video display controller to display each character. Each character is defined in the ROM by 16 bytes. The first nine bytes are determined from the coding of 9 rows by 8 columns matrix. This matrix is first used to determine the dots location for a particular character. The hex value of each row then constitute an 8-bit value. These 9 rows thus define the first 9 bytes for the character and the remaining bytes for the character are zeros.

The Video Display Controller

The video display controller consists of a Signetics 2672 programmable video timing controller (PVTC), 2K bytes of display buffer memory, a display character generator ROM, and video and atrribute control circuitry.

The display buffer does not take any memory space in the system RAM, as it has its own 2K bytes of internal memory for storage of one full screen of display characters. It is made up by four 1024 x 4 bits static RAMs.

The PVTC derives its timing from an external character clock generator which uses a 13.000 MHz crystal as its time basis and generates all the display timing, including scan line per character row, video dot timing, composite sync and other control signals necessary for the display data on a CRT terminal.

It also provides consecutive addressing to the display buffer memory and controls the CPU-display buffer interface. Transfer of data between the CPU and the display memory is accomplished via a write display buffer and a read display buffer which is controlled by the signals write data buffer WRD/, read data buffer RDB/ and buffer chip enable CE/.

During a write operation, data is loaded by the CPU into the write display buffer, and the PVTC outputs the specified display buffer address and activates the WRD/ and CE/ signal to complete the operation.

During a read operation, the CPU issues a read command and the PVTC outputs the display buffer address and activates the RDB/ and CE/ to latch data from the display buffer onto the read display buffer. When the CPU detects the ready flag set by the PVTC, it reads data from the read display buffer.

Data transfer is performed during the blanking interval in order to prevent visual disturbance of the display data.

The PVTC is programmable for a variety of display formats and timing profiles on either the monitor display or on a television. The characteristics for the monitor and television mode can be summarized as follows:

	Monitor	Television
Scan lines per screen	216	216
No. of character row	24	24
No. of character column	80	40
Character clock time	13.0 MHz	6.5 MHz
Character width in dot	8	7

The character clock time and character width is controlled by the signal lines 40COL and DIV7-8/ respectively.

The dot pattern display for characters in the display memory is controlled by the scan column lines DAD3-DAD7 and the ASCII value read from the display buffer. Both the scan column lines and character address lines DAD0-DAD9 are provided by the PVTC. The dot pattern read from the character generator ROM is then serially shifted out to the video control circuit where the composite video is generated and special visual attributes are produced.

The attribute circuitry can produce highlighted, reverse video and black-on-white video effects on the screen, depending on the signals of HIL, REV and BOW respectively, and also the attribute bit CC7. A composite sync signal conforms to the EIA RS170 Standard. All the timing and video signals are generated by the video circuit which is then output to both the composite video and RF jacks.

The Video Connector J2

This is an RCA phone jack connector for hook up to any standard video monitor compatible with the RS170 standard.

The pin assignments for the interface signals are as follows:

Pin No.	Description
1	Composite video signal of approximately 1.5v peak to peak amplitude into an 75 ohm load impedance.
2	Chassis ground.

The RF Video Connector J4

This is a 5 pin Din type socket compatible with the ASTEC UM1381 video modulator or any FCC approved video modulator with the same pinout and signal configuration.

The pin assignments for the video connector are as follows:

Pin No	Description
1	12V DC supply
2	Video shield ground: 0V
3	Audio Out. 1.0V p-p: AC coupled.
4	Video Out. 0.8V p-p: AC coupled.
5	Not connected.

Socket Pinout Diagram

Printer

The standard parallel interface that comes with the PIED PIPER is a Centronics standard. Data strobe is provided via the command register, bit 3.

The printer can be accessed directly through the register described below, in addition to the CP/M LISTOUT BDOS entry point.

Addressing

Data Register: ODH

Principle of operation

To send a character to the printer, the following steps are required:

i) Make sure printer is ready
ii) Send data byte to data register
iii) Set data strobe high
iv) Delay to compensate for paper movement
v) Reset data strobe

The printer status and data strobe manipulation involves the status and command register respectively. The current value of the command register can be obtained from the memory location OFFE2 hex.

```
NOTRDY:

    IN      A,18H:              GET STATUS
    BIT     5,A:                CHECK IF READY
    JR      NZ,NOTRDY:          REPEAT IF BUSY
    LD      A, data value
    OUT     ODH,A:              SEND TO DATA REGISTER
    LD      A,(OFFE2H):         GET COMMAND REG. VALUE
    SET     3,A:                SET DATA STROBE HIGH
    OUT     18H,A
    DELAY
    RES     3,A:                RESET DATA STROBE
    OUT     18H,A
```

The Parallel Printer Port

This is a 15 pin D-type female connector which can hook up to any Centronics compatible printer. It consists of eight bit data lines and two control lines for printer handshaking. The signal descriptions are as follows:

Signal Name	Signal Flow	Description
DATA1-DATA8	Output	Data Lines. These eight data lines are used to transmit data to the printer. DATA8 is the most significant bit.
DSTA	Output	Data Strobe. The printer should use this signal line to strobe in the data on the data lines.
PRBUST	Input	This line should be high when printer is busy or not ready to receive data from the printer port.

Parallel Printer Connector J3 Pin Assignments

Pin No.	Signal Name
1	DATA1
2	DATA2
3	DATA3
4	DATA4
5	DATA5
6	DATA6
7	DSTR
8	PRBUSY
9	DATA7
10	DATA8
11	GROUND
12	GROUND
13	GROUND
14	GROUND
15	GROUND

Floppy Disk

The floppy disk is the tool by which programs and data are loaded into memory. The disk drive that comes with the PIED PIPER is a 5-1/4" floppy disk drive. The floppy diskettes are double sided, double density and 96 tracks per inch. The unformatted capacity is 1 Mbyte, and the formatted capacity is 800 Kbyte.

Although one can always use the controller register set to perform disk I/O, some of the basic operations are already available from the bootstrap ROM. These routines, which are also used by the CP/M operating system, are described in more detail in the useful routines section.

Addressing

Command Register:	10H - Write only
Status Register:	10H - Read only
Track Register:	11H
Sector Register:	12H
Data Register:	13H

Initialization

No special initialization is required for the floppy disk controller. The diskette that is to be used on the PIED PIPER, together with the CP/M operating system, must first be formatted. The user's manual has a detailed description on the utility program that does this.

Command Register - 10H

The following table summarizes the commands supported by the floppy disk controller used in the PIED PIPER:

D7	D6	D5	D4	D3	D2	D1	D0	Type	Command
0	0	0	0	h	V	r1	r0	I	Restore
0	0	0	1	h	V	r1	r0	I	Seek
0	0	1	u	h	V	r1	r0	I	Step
0	1	0	u	h	V	r1	r0	I	Step In
0	1	1	u	h	V	r1	r0	I	Step Out
1	0	0	m	F2	E	F1	0	II	Read Sector
1	0	1	m	F2	E	F1	a0	II	Write Sector
1	1	0	0	0	E	0	0	III	Read Address
1	1	1	0	0	E	0	0	III	Read Track
1	1	1	1	0	E	0	0	III	Write Track
1	1	0	1	I3	I2	I1	I0	IV	Force Interrupt

h = Head load flag
= 1, load head at beginning
= 0, unload head at beginning

V = Verify flag
= 1, verify on destination track
= 0, no verify

r1r0 = Stepping motor rate
= 00 for the PIED PIPER disk drive, i.e. 6 ms.

u = Update flag
= 1, update track register
= 0, no update

m = Multiple record flag
= 1, multiple records
= 0, single record

a0 = Data address mark
= 1, F8 (Deleted data mark)
= 0, FB (Data Mark)

E = 15 ms delay
= 1, 15 ms delay
= 0, no 15 ms delay

F2 = Side select flag
= 1, compare for side 1
= 0, compare for side 0

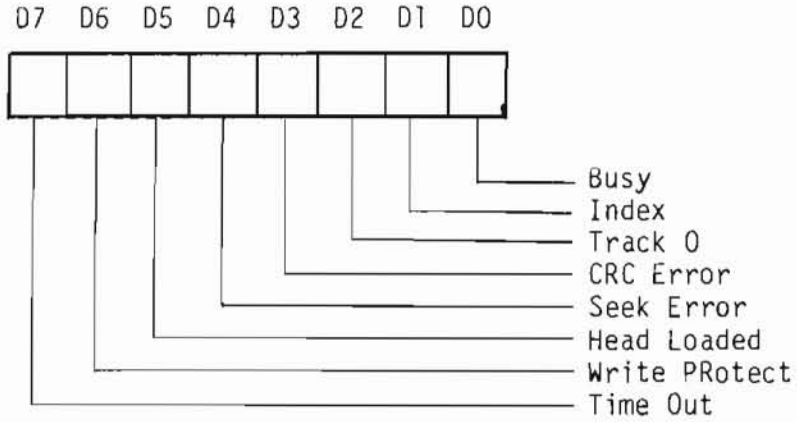
F1 = Side compare flag
= 1, enable side select compare
= 0, disable side select compare

I0, I1, I2, I3 = Interrupt condition flags

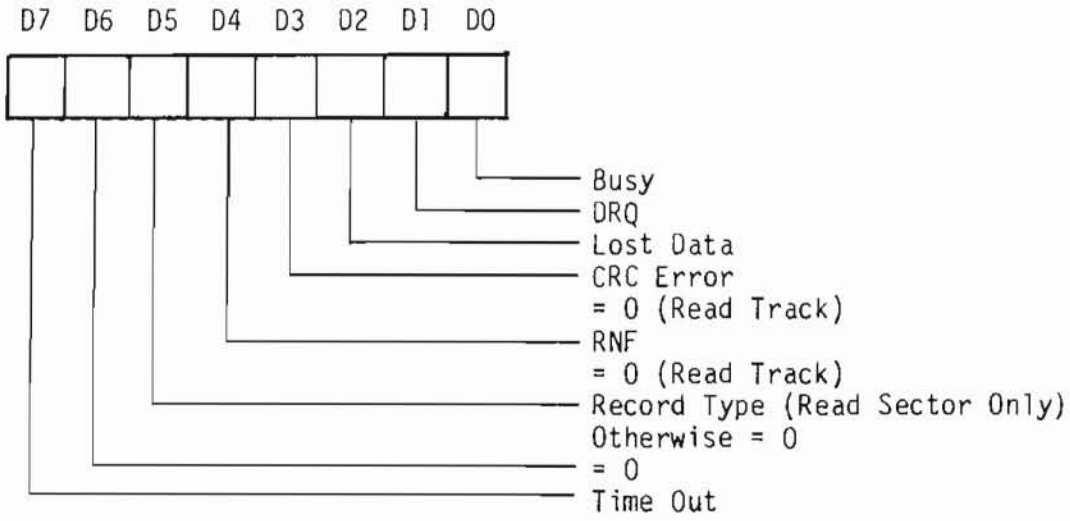
I0 = 1, not ready to ready transition
I1 = 1, ready to not ready transition
I2 = 1, index pulse
I3 = 1, immediate interrupt
I3 = I0 = 0, terminate with no interrupt

Status Register - 10H

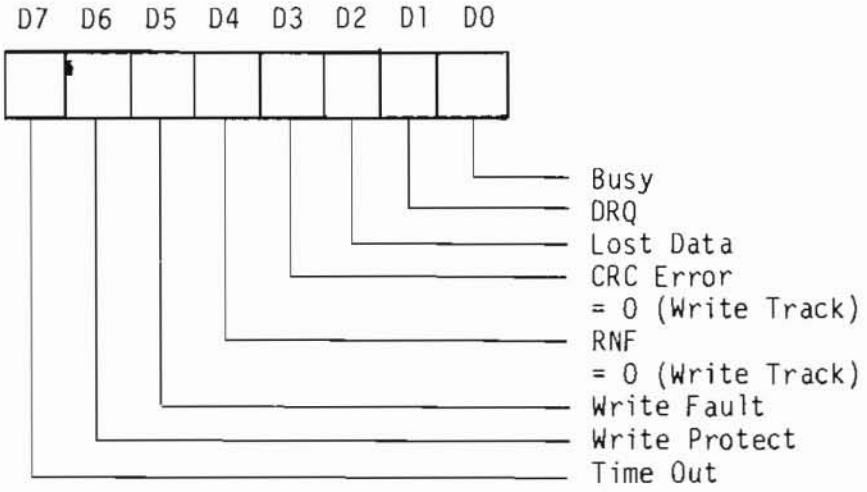
Type I Command



Read Commands (Read Address, Read Sector, Read Track)



Write Commands (Write Sector, Write Track)



Diskette Format

The formatting method used is MFM.

The physical format of a formatted diskette:

```
512 bytes/sector
 10 sectors/track
  2 tracks/cylinder
 80 cylinders/disk
```

The logical format as seen through CP/M:

```
6272: 128 Byte Record Capacity
 784: Kilobyte Drive Capacity
 256: 32 Byte Directory Entries
 256: Checked Directory Entries
128: Records/Extent
 16: Records/Block
 40: Sectors/Track
  3: Reserved Tracks
```

Blocking Factor:

4 logical sectors (128 bytes) per physical sector (512 bytes)

Sector translation information:

Skew factor = 2

Logical sector	Physical sector
1,2,3,4	1
5,6,7,8	3
9,10,11,12	5
13,14,15,16	7
17,18,19,20	9
21,22,23,24	2
25,26,27,28	4
29,30,31,32	6
33,34,35,36	8
37,38,39,40	10

Formatting Information:

	# of bytes	HEX value
	50	4E
	12	00
	3	F6
	1	FC
	50	4E
---┬---	12	00
|	3	F5
|	1	FE
|	1	Track number (00 to 4F)
|	1	Side number (00 to 01)
|	1	Sector number (01 to 0A)
|	1	02
* |	1	F7
|	22	4E
|	12	00
|	3	F5
|	1	FB
|	512	E5
|	1	F7
---┴---	32	4E
**	1680	4E

* Write bracketed field 10 times
**Approximate

Useful Routines

There are four useful routines that are used by the floppy disk interface:

- Disk drive selection and side selection
- Restore, seek, steps handling
- Read, write handling
- Timing delay

These routines can be called through a jump vector starting at memory location OFFF3 hex.

FDRWS - jump vector OFFF3 hex

DSKSEL - jump vector OFFF6 hex

Type 1 - jump vector OFFF9 hex

DELAY - jump vector OFFFC hex

FDRWS - Floppy Disk Read/Write.

This routine is used for handling read and write of the floppy disk. This routine only sets up the command value and directs it to the command register. The physical input/output is performed by the interrupt routine.

There are two input parameters for this routine. One is the floppy disk command, whch can be read or write, and is passed through the accumulator. The other parameter is the starting address of the data buffer; this is passed via the HL register pairs of the Z80A processor. The value of the status register at the completion of the command is passed back through the accumulator.

e.g.,

1) To read a sector from the disk: the disk must have been selected with the read/write head position at the proper track and the proper side selected.

```
LD    A,10000010B:  SET UP READ SECTOR COMMAND
LD    HL,buffer address
CALL  0FFF3H
```

2) To write a sector to the disk:

```
LD    A,10100010B: SET UP WRITE SECTOR COMMAND
LD    HL, buffer address
CALL  0FFF3H
```

DSKSEL - Floppy Disk Selection; Side Selection

This routine is used for selecting the floppy disk drive A or drive B, and also for switching from one side to the other. This routine updates the memory location OFFE2 hex to keep the current value of the command register up to date.

Since the drive selection or side selection process only affects the three least significant bits of the command register, the only input parameter for this routine is the target value of the three least significant bits of the command register. This input parameter is specified by the accumulator of the Z80A processor.

Note that when switching sides, the drive selection bit for the target disk drive must also be set on the input parameter.

The routine first obtains the current value of the command register, then updates the three least significant bits based on the input parameter, saves the new value of the command register in memory location OFFE2 hex, and finally sends the value to the command register.

e.g., to select drive B side 1

Input: A - 00000110

```
LD    A,00000110B
CALL  OFFF6H
```

TYPE 1 - Restore; step; seek

This routine handles all the TYPE I commands as defined in the Western Digital Floppy Disk Controller Specification. Among the TYPE I commands are restoring the disk, seeking a track, and stepping from one track to another.

The only input parameter for this routine is the command value, which is passed through the accumulator of the Z80A processor. The value of the status register at the completion of the command is passed back through the accumulator.

e.g.,

1) To restore drive A with verify:

```
LD   A,00000001B:   SELECT DRIVE A
CALL OFFF6H
LD   A,00001100B:   SET UP RESTORE COMMAND
CALL OFFF9H
```

2) Continuing the above example, to step in one track:

```
LD   A,01011100B:   SET UP STEP-IN COMMAND
CALL OFFF9H
```

3) To seek to Track 40:

```
LD   A,40:          SET UP TARGET TRACK
OUT  13H,A:         SEND DATA TO REGISTER
LD   A,00011100B:   SET UP SEEK COMMAND
CALL OFFF9H
```

DELAY - Software timing loop of 1 millisecond.

This routine performs a delay loop of approximately 1 millisecond. This routine is used mainly before and/or after issuing a TYPE I command, since there are certain timing requirements for some of these commands.

No input parameter is required for this routine.

The Floppy Disk Drive Controller

The PIED PIPER's floppy disk drive controller is built around the Western Digital FD1793 Floppy Disk Formatter/Controller which is configured for 5-1/4" mini floppy disk drive in double density format.

The controller performs all the functions necessary to read and write data to the drive. On Disk Read operation, data from the disk in Modified-Frequency-Modulated (MFM) format is fed into the data separator circuit, made up by FDC 9216 to retrieve the RAW READ data and the READ CLOCK signals. The serial data is then converted into parallel and transferred to the CPU via the data bus lines. The read operation continues until the end of the sector is reached and set on the Interrupt request line.

On Disk Write operation, the Write Gate is enabled. Write data in the form of a series of pulses in MFM format is output to the drive. Write Precompensation is done digitally by the shift register 74LS195 and depends on the states of Write Data, EARLY and LATE signals.

Writing to the disk is inhibited when the Write Protect input is at a logical low, in which case any Write Command is immediately terminated.

Floppy Disk Drive Interface Connector J12

This is a 40 pin male connector for hookup to 5-1/4" mini floppy disk drives. it consists of all the signals required for disk read/write data transfer, motor stepping and step direction, drive status and drive selection. The signal descriptions are as follows:

Signal Name	Signal Flow	Functional Description
DR1/	Output	Enables the Drive Unit A.
DR2/	Output	Enables the Drive Unit B.
MOTOREN/	Output	Enables the drive motor.
DIR/	Output	Controls the direction of the Read/Write head movement. Low indicates movement away from the center of the drive and high indicates movement towards the center of the drive.
STEP/	Output	Steps the read/write head by one track for each step pulse output. Its direction is specifierd by DIR/.
SS/	Output	Side Select. It is low when side 1 of the diskette is selected and high when side 0 is selected.
WD	Output	Writes data to disk drive in MFM formats.
WG/	Output	Write Gate Enable. It is turned on when writing is to be performed on the diskette.

Signal Name	Signal Flow	Functional Description
RD	Input	Reads data from the diskette drive.
Index/	Input	Index Hole Detect. This line is low when the index hole is encountered on the diskette.
TRK00/	Input	Track Zero Indicator. This line is low when drive head is positioned at track zero and high when it is away from track zero.
WPRT/	Input	Diskette Write Protect. This line is low when the diskette is write prohibited.

Expansion Slots

There are three expansion connectors available on the PIED PIPER. These expansion connectors can be used by the OEM for specialized applications.

The PIED PIPER option cards use the expansion connector J7 and J8. The RS232+Modem option card uses connector J7, while the Liquid Crystal Display option card uses connector J8.

Addressing:

	Base address	
Expansion J7:	28H - 2FH	38H - 3FH
Expansion J8:	20H - 27H	38H - 3FH
Expansion J1:	38H - 3FH	

The Expansion BUS Connector J1

This is a 56 pin card edge connector which can be used to interconnect with other external peripherals or I/O devices which are STD BUS compatible and for future expansions.

The Expansion BUS organization consists of a power bus, a data bus and a control bus. The signals are as follows:

Signal Name	Signal Flow	Description
DB0-DB7	Bi-direction	Data bus lines
AB0-AB7	Output	Address bus lines
WR'/	Output	Write to memory or I/O
RD'/	Output	Read from memory or I/O
MREQ/	Output	Memory address select
RESET/	Output	System reset
INT0/	Input	Interrupt request
INTAK/	Output	Interrupt acknowledge
NMI/	Input	Non-maskable interrupt
WAIT/	Input	Wait request
AUDIO	Output	Audio Output to RF modulator
BUSRQ/	Input	Bus request
BUSAK/	Output	Bus acknowledge
IORQ'/	Output	I/O Request
CS7/	Output	I/O select. Also used by peripheral card connector J7 and J8.
CLK	Output	Clock from processor.

The Expansion BUS Connector J1 Pin Assignments

Pin No.	Signal Name	Pin No.	Signal Name
1	+5V DC	2	+5DC
3	Ground	4	Ground
5	Not connected	6	Not connected
7	DB3	8	DB7
9	DB2	10	DB6
11	DB1	12	DB5
13	DB0	14	DB4
15	AB7	16	Not connected
17	AB6	18	Not connected
19	AB5	20	Not connected
21	AB4	22	Not connected
23	AB3	24	Not connected
25	AB2	26	Not connected
27	AB1	28	Not connected
29	AB0	30	Not connected
31	WR'/	32	RD'/
33	IORQ'/	34	MREQ/
35	AUDIO	36	CS7
37	Not connected	38	Not connected
39	Not connected	40	Not connected
41	BUSAK/	42	BUSRQ/
43	INTAK/	44	INTO/
45	WAIT/	46	NMI/
47	RESET/	48	Not connected
49	CLK	50	Not connected
51	Not connectedl	52	Not connected
53	Ground	54	Ground
55	+12V DC	56	-12V DC

Peripheral Card Connectors

There are two 28 pin single row male connectors J7 and J8 on the board which can be used to interface with user designed I/O devices and for future expansion options.

The signal descriptions and pin assignments for connector J7 are as follows:

Pin No.	Signal Name	Signal Flow	Description
1	AB0	Output	Address Line 0
2	AB1	Output	Address line 1
3	AB2	Output	Address line 2
4	Ground		Signal Ground
5	Ground		Signal Ground
6	+5V	Output	+5V DC
7	CS5/	Output	I/O Select
8	RESET/	Output	System Reset
9	CLK	Output	System Clock
10	INT1/	Input	Interrupt Request
11	AUDIO	Output	Audio output to RF modulator
12	DB7	Bi-direction	Data line 7
13	DB6	Bi-direction	Data line 6
14	DB5	Bi-direction	Data line 5
15	DB4	Bi-direction	Data line 4
16	DB3	Bi-direction	Data line 3
17	DB2	Bi-direction	Data line 2
18	DB1	Bi-direction	Data line 1
19	DB0	Bi-direction	Data line 0
20	+5V	Output	+5V DC
21	Ground		Signal Ground
22	Ground		Signal Ground
23	IOWR'/	Output	I/O write
24	IORD'/	Output	I/O read
25	WAIT/	Input	Wait request
26	CS7	Output	I/O select
27	+12V	Output	+12V DC
28	-12V	Output	-12V DC

Signal Descriptions and Pin Assigments for Gus Connector J8

Pin No.	Signal Name	Signal Flow	Description
1	AB0	Output	Address Line 0
2	AB1	Output	Address line 1
3	AB2	Output	Address line 2
4	Ground		Signal Ground
5	Ground		Signal Ground
6	+5V	Output	+5V DC
7	CS4/	Output	I/O Select
8	RESET/	Output	System Reset
9	CLK	Output	System Clock
10	INT2/	Input	Interrupt Request
11	AUDIO	Output	Audio output to RF modulator
12	DB7	Bi-direction	Data line 7
13	DB6	Bi-direction	Data line 6
14	DB5	Bi-direction	Data line 5
15	DB4	Bi-direction	Data line 4
16	DB3	Bi-direction	Data line 3
17	DB2	Bi-direction	Data line 2
18	DB1	Bi-direction	Data line 1
19	DB0	Bi-direction	Data line 0
20	+5V	Output	+5V DC
21	Ground		Signal Ground
22	Ground		Signal Ground
23	IOWR'/	Output	I/O write
24	IORD'/	Output	I/O read
25	WAIT/	Input	Wait request
26	CS7	Output	I/O select
27	+12V	Output	+12V DC
28	-12V	Output	-12V DC

IN THIS SECTION:

- Operating System
- Utility Programs
- Application Programs

SOFTWARE INFORMATION

Operating System: CP/M 2.2

The PIED PIPER utilizes CP/M 2.2 for its operating system. Many utilities and programs are included with the PIED PIPER (described below). Additionally, most programs designed to run on CP/M 2.2 run perfectly on the PIED PIPER.

The latest software catalog will be supplied, and updated, in your regular dealer newsletter.

CP/M AND PIED PIPER UTILITIES:

TV

The TV program is used to convert the screen display to 40 characters in width. This enables you to use a television set as a display device for your computer. (Television sets can display only 40 of the 80 characters possible at any one time.)

STAT

The STAT or Status command is used to provide information about the size and status of the files on the diskettes you use.

PREPARE

The PREPARE program prepares new diskettes for use on the system. PREPARE performs the functions of formatting, verifying and copying the CP/M operating system to the diskette with one single command.

VERIFY

The program VERIFY is a stand-alone program which allows you to check any diskette for errors without performing the other PREPARE functions. This is useful for checking old diskettes or any problem diskettes for errors.

TRANSFER

The TRANSFER program is used to copy single files from one diskette to another using a single disk drive. A wild card function operates using the "*" to make multiple file copying simpler. This is the program to use when backing up recently created data files on a disk. It is user friendly, with continuous prompts.

COPY

This program is used to copy the entire contents of one diskette to another using a single disk drive.

CP/M 2.2 software included with the PIED PIPER:

DDT	Technical debugging/programming tool
ED	Text editor
ASM	Machine code compiler
SUBMIT	Command line automation
MOVCPM	Adjust CP/M to memory capacity
SYSGEN	Places CP/M system on a disk
PIP	Copies files from one place to another
XSUB	
LOAD	Load a file from disk
DUMP	Save memory to disk

PIED PIPER™

PERFECT WRITER

Perfect Writer gets better notices than any other word processing program on the market.

Multiple Editing Buffers with Split Screen: With virtual memory, you can work in and edit up to seven files, up to as many as 200 pages of text.

Dual Display Windows: View and edit two of the seven on-line files on your CRT screen at the same time. You can even scroll through one file while editing in the other.

User-Selectable Commands: Use Perfect Writer's highly logical commands, or redefine them to your own liking. Even the arrow and function keys are at your command.

User-Protection Features: Perfect Writer automatically saves your document as you write - after every paragraph of text. And the "oops! option" lets you recapture accidental deletions.

Document Design Bonuses: Ninety-one (91) built-in page and document design formats.

Just press one key when you are ready to insert a quotation, itemize a list, or change a type face. Style options permit you to override the default settings to suit your personal preferences.

Multiple Mailings Management: Insert one-of-a-kind from your keyboard as your document is printing. Or select and insert blocks of special text from existing files. Merge Perfect Filer mailing lists to achieve unmatched levels of personalization.

Automatic Footnotes and Intext Referencing: As you write, Perfect Writer places footnotes just where you want them - properly numbered in the text, at the bottom of each page, or at the end of the document. It tags text for automatic referencing with the document, too.

Automatic Index and Table of Contents: Key words of your choice can be tagged for inclusion in an alphabetized and paginated index. Press a key and the index is automatically generated. A Table of Contents is produced in the same way.

In Context Spelling Checker: Perfect Speller displays your spelling errors in the context of your document. Checks 4,000 words per minute against a 40,000 word dictionary, including additional words unique to your subject. Perfect Speller even catches and corrects document design errors.

PIED PIPER™

PERFECT FILER

Perfect Filer works hard behind the scenes with other Perfect programs for easy, fast and accurate records management.

With Perfect Filer, you type important information just once. When you are ready to use your data, Perfect Filer will find it for you, then print it with total accurcacy how and where you want it - on monthly statements, shipping labels, form letters, audit forms . . . you name it.

Incorprate Perfect Filer files as a vast data resource to support your financial projections. Store stock quotations, earnings tables, advertising response data, or sales territory call reports.

Use Perfect Filer to handle accounting functions and see it pay off. For example, when you are ready to prepare invoices, a few simple commands produce your entire accounts receivable ledger.

Mailings: Link your address file, pre-sort and "comments" file. Envelopes for those customers whose invoices require special attention are then printed automatically with a "comment" of your choosing.

If you need to reach your client list en masse, yet in a personal way, Perfect Filer will generate individually addressed form letters. You can even target certain portions of your mailing list for special attention during printing.

Here are just a few Perfect Filer special features:

- Two mailing list data bases provided: one for individuals, one for organizations
- Easy, menu-guided programs help you create customized data bases - in under five minutes.
- Versatile sort routines permit up to five simultaneous sorts on up.
- Subset definitions allow up to 20 selective subsets for a single data base. Relational operators, date/time, and financial formats are all buit-in.
- Easy list-format procedures help generate lists, labels, invoices, checks, forms, and reports - all just as you want them.
- Integrated command structure just like all other Perfect Software. Learn just one set of easy commands, one time.

PIED PIPER™

PERFECT CALC

Perfect Calc is simply unmatched by any other product in the industry.

It handles much more than standard row-and-column financial forecasting. In fact, Perfect Calc's user-expandable function library provides limitless capabilities. Expand the library to include any function unique to your interests - any application requiring specialized functions.

Supplied with Perfect Calc are 17 applications programs. Fully integrated, they include Cash Flow and Income Statements, Weekly/Monthly Payroll Statements, even Stocks and Bonds, and Personal Income Tax. All come ready to use.

Call up the Budgeting program, for example, and just fill in the blanks. Change a figure and every other related file - up to seven - is automatically updated.

You record your raw data just once, in just one place. Then move it and merge it between the Perfect programs with the same simple keystroke sequences you use in Perfect Writer. No more bulky, line-oriented command hierarchies.

True program integration such as this means that you can use Perfect Calc for any application that requires planning and financial control: engineering, agriculture, trucking, politics, scientific research - the possibilities are endless.

With Perfect Calc, you can copy a file to buffer, then display both the original and the copy on a split screen. This way, you can perform "what if" calculations in the file displayed on the top half of the screen while comparing it to its original form on the lower half.

That's just for starters. Perfect Calc really begins to shine when you want to share results between files and other Perfect programs while continuing to ask "what if" questions. Put as many as seven files on line at once and perform "cut and paste" changes. Move characters, lines of figures, even whole regions. Presto.

When you are satisfied with the data you have entered in your Perfect Calc spreadsheet, merge and correlate it with your other Perfect Calc spreadsheets. You can even gather data from Perfect Filer lists.

Include your forecasting summary in any Perfect Writer document for a truly convincing final presentation.

The following is a list of application programs that have been tested on the PIED PIPER:

1. System Tools

DESPOOL	Utility program from Digital Research, Inc. which permits simultaneous printing from existing text files during data entry, editing or debugging. Will operate with any program that interacts with system console, but only effective if executed program has significant amount of console input.
MACRO-80	Assembly language development package from Microsoft Corporation. For Z80 and 8080 assembly language programming; it supports both Intel and Zilog mnemonics. The assembler produces relocatable, linkable output. The whole package contains four modules: Macro-80 (relocatable macro assembler), Link-80 (linking loader), CREF-80 (cross reference list facility) and LIB-80 (library manager).
ZSID	Z80 Symbolic Debugger from Digital Research Inc. Similar to SID, the 8080 Symbolic Debugger.

2. Telecommunications

MODEM 7	Utility for transferring files between two computers. Available from CP/M User Group CPMUG.
ASCOM	Utility for transferring files between two computers. It features menu driven commands plus on-line help facility.
BSTAM	Utility for transferring files between two computers. Supports either binary or ASCII files. Transmits at 9600 baud with wire and 300 baud with phone line over modem.
MicroLink-80	File transfer utility for binary or ASCII files. Has error correction protocol.

3. Languages

MBASIC	From Microsoft Corp. The BASIC Interpreter is the most extensive implementation of BASIC available for microprocessors.
FORTRAN-80	ANSI '66 plus enhancements. Fortran compiler from Microsoft Corp. Comes with the MACRO-80 development package.
PASCAL/MT	Available from Digital Research Inc. Supports the entire International Standards Organization (ISO) standard plus extensions.
PASCAL/Z	Pascal compiler from Ithaca InterSystems. Generates native Z80 code.
CBASIC	From Digital Research Inc.

4. Office Applications

WordStar	Word processing package from MicroPro. What you see is what you get. The screen shows exactly what will be printed. Features automatic pagination, justification, and hyphenation. User aids include online help menus, reference card, and training guide.
MailMerge	Powerful multipurpose file merging program. Together with WordStar, form letters, mailing labels, invoice, and boilerplate legal documents can be generated with ease.
DataStar	Data handling program allowing entry, retrieval, and update of data to be a relatively simple task. Form definition program allows custom designed data entry forms. Can be used together with WordStar, MailMerge and SuperSort to generate a variety of business applications.
SpellStar	Spelling checker program that works with WordStar to find spelling and typing errors. 20,000 word dictionary.

SpellStar	Spelling checker program that works with WordStar to find spelling and typing errors. 20,000 word dictionary.
CalcStar	Electronic spreadsheet and financial modeling program. Can be used together with WordStar to take advantage of printing options such as boldface and underlining to dress up the financial documents.
SuperSort	Can sort and merge up to 32 files into a single file at a rate of 560 records per minute or better. Data record can include upper or lower case letters, floating decimals, and exponential notation.
Spellguard	Spelling checker program.
SuperCalc	Electronic spreadsheet program from SORCIM Corporation. User aids include on-line help messages. Answer card for quick reference and lessons in user guide.
Scratchpad	Electronic spreadsheet program that features virtual memory. It provides virtually unlimited number of entries, unlimited number of screen splitting and unlimited title locking. Only limit is the capacity of the disk drive.
PLAN80	Electronic spreadsheet program. Models are constructed with descriptive names assigned to columns, rows and entries which make understanding and referencing a simple task. Models can be defined using an editor.
dBASE II	A powerful relational information handler. Uses English-like language. Manipulates data from entire data bases down to single character in a data field. Can be customized to generate a wide variety of business applications.
T/Maker III	Word processing, spread sheet and file management program.
Money Maestro	Financial management program.
Milestone	A project management and time scheduling program using the critical path technique.

PIED PIPER™

MARKET FEEDBACK FORM

We at STM Electronics are vitally interested in hearing from you, our dealer. Please use the enclosed MARKET FEEDBACK FORM to let us know about anything you feel is important. We have made several product improvements based on specific information from these forms.

If there is a problem with the product regarding service or advertising, for example, feel free to let us know. Additionally, if you would like to see changes or improvements, the MARKET FEEDBACK FORM is a great way to let us know.

Once we receive your input, STM will contact you either by phone or through correspondence. Don't worry about running out of MARKET FEEDBACK FORMS because we will send you some every time we receive a completed form.